Remarks on "Artificial Intelligence, Logic and Formalizing Common Sense," by John McCarthy[1]

Richmond H. Thomason
Philosophy Department
University of Michigan

rich@thomason.org

[McCarthy, 1989] appeared in a volume of papers on philosophical logic and artificial intelligence that I edited in 1989. The purpose of that volume was to make philosophers better acquainted with work in logicist AI. From that standpoint, the volume wasn't especially successful—philosophers are still ignoring this work. But it might be useful to explain— even to this audience—why they shouldn't avoid it. It gives a sense of the wider significance of the program that John presented in the 1989 paper, and it might help you to be persuasive when you talk to philosophers. I can use all the help I can get in convincing them to take work in AI seriously.

McCarthy's paper explains what he means by "common sense," why since 1959 he has thought it is fundamentally important for achieving human-level AI, and describes its relation to science. It discusses adequacy conditions for a logic capable of representing general, reusable common sense information. Then it goes on to describe how this goal creates a need for new logics. Specific topics and projects dissucssed in the remainder of the paper include (1) nonmonotonic logic, (2) ability, practical reason, and free will, (3) knowledge and belief, and (4) reifying context.

I have worked in philosophical logic since the early 1960s, and was editor of the *Journal of Philosophical Logic* for about thirteen years starting in 1974. So I have thought a great deal about this field—its relation to logic in general, its goals, and how best to achieve them. My ideas about how to define the field and characterize its goals and methods were changed by the ideas in McCarthy's 1989 paper.

Modern logic was created to account for mathematical reasoning, and the logicist projects of Frege and Russell were attempts to formalize mathematics (or at least analysis) as a definitional extension of logic. But there is much reasoning that is not mathematical, and you would hope that logic would be helpful in dealing with that. The mathematical logicians are the ones who concentrated on the logic that is needed to formalize mathematics, with growing attention to the mathematical properties and uses of this logic. The philosophical logicians are the ones who wondered how this logic could be applied more generally.

Of course, these two tendancies in logic can be hard to separate. And the recent history of logic is (excitingly) complicated by the addition of a group of computational logicians. But I think this story fits the trends in logic in the twentieth century.

Carnap, for instance, was a philosophical logician. He was interested in modal logic,

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inductive logic, and the formalization of nonmathematical domains.[2] Richard Montague was a mathematical logician who later became interested in a project that definitely belonged to philosophical logic: devising a logic that would be adequate for the interpretation of natural languages. Problems with Montague's intensional logic—for instance, difficulties in interpreting verbal aspect, the distinction between mass and count nouns, and plurals—precipatated further projects in philosophical logic.

Philosophical Logic emerged[3] as the field devoted to the development of logics that might be suitable for formalizing nonmathematical reasoning. But there was no real attempt, as far as I know, to identify *domains*—areas in which nonmathematical reasoning is engaged in solving certain types of problems—to develop suitable logics for these domains, and to systematically formalize the reasoning. Instead, the focus was on *constructions* and *topics*. Constructions included epistemic operators, tense, conditionals, and indexicals. Topics included presupposition and vagueness. This work tended to be local in scope. A typical project would identify a construction or topic, develop a logic differing from classical logic in a a few simple ways, and test the validities produced by the logic against a few artificially constructed example inferences.

McCarthy's 1989 paper not only mentions specific projects in philosophical logic, but recommends a different methodology for the field.[4] He makes the following recommendations. These have to do mainly with matters of scale. But, as we know, scaling up can be nontrivial, and in particular can force you to rethink your approach in a fundamental way. I believe that the implications for philosophical logic are fundamental in just this way.

- Projects should investigate entire reasoning domains, and should try to achieve adequate coverage of the reasoning in these domains.
- Projects should seek to develop large-scale, elaboration tolerant formalisms capable of dealing with large amounts of knowledge and complex reasoning problems.
- Logics will be needed that meet the needs of the formalization projects.

Reconceived in this way, the overall project is one that has to be addressed by a scientific community, rather than a more or less independent collection of independent researchers. This is another consequence of the change in scale.

There are potential consequences here not just for philosophical logic, but for philosophy. Consider the analogy to the influence of Frege, Russell, and Tarski on Anglo-American philosophy in the twentieth century. Direct attempts to use logic to provide solutions to the big philosophical problems were not very successful. (I am thinking here of Russell's logical atomism, Wittgenstein's *Tractatus*, and Carnap's logical phenomenalism.) But logic could be used, and was used, to clarify philosophical thinking on issues throughout the field.

[2]His attempt in [Carnap, 1936–1937] to formalize *dispositionals* (in particular, an attempt to define 'water-soluble' in terms of 'water' and 'dissolves') failed, I believe, because he didn't have a nonmonotonic logic.

[3]Perhaps you can date the separation from mathematical logic to 1972, when the *Journal of Philosophical Logic* was founded,

[4]Intentionally, I make no distinction between philosophical logic and logicist AI. I don't think that there are important differences in the goals or methods of the two fields.

Because of the use of logic, the presentation of issues and the development of positions has gradually become more sophisticated in ways that otherwise would have been impossible. There are examples in metaphysics and philosophical ontology (David Lewis, Achille Varzi), causality (David Lewis, Clark Glymour and many others), probabilistic epistemology (Richard Jeffrey and many others), theories of reference and truth (Kripke), and subjective attitudes (Stalnaker).

I believe that logicist AI has the potential to have a similar impact on philosophical research. As before, I don't think that ideas from the formalization of common sense will solve the big problems. But it can provide similar advances in methodological clarity and insight into moderate-sized problems.

In fact, the list in [McCarthy, 1989]—nonmonotonic logic, ability and practical reason, knowledge and belief, and reifying context, provides an inventory of logical material that, if it could be further developed by logicians and digested by philosophers could fruitfully inform philosophy for much of the present century.

References

[Carnap, 1936–1937] Rudolph Carnap. Testability and meaning. *Philosophy of Science*, 3 and 4:419–471 and 1–40, 1936–1937.

[McCarthy, 1989] John McCarthy. Artificial intelligence, logic, and formalizing common sense. In Richmond Thomason, editor, *Philosophical Logic and Artificial Intelligence*, pages 161–190. Kluwer Publishing Co., Dordrecht, Holland, 1989.